

LISTING OF THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claims 1-17 (cancel)

18. (Currently Amended) A method of producing hydrogen comprising: providing a steam feed stream at one side of a porous redox stable substrate, contacting said steam feed stream with a proton conducting membrane supported on the other side of said porous redox stable substrate, through said substrate, said membrane being substantially non-permeable to molecular gas and to oxide ions, applying a DC voltage across an anode coupled to the substrate side of said membrane and a cathode coupled to the other side of said membrane so as to dissociate at least part of said steam feed stream therebetween, into protonic hydrogen and oxygen at said anode, allowing said protonic hydrogen to pass through said membrane and form molecular hydrogen at said cathode, and collecting said molecular hydrogen, wherein the membrane comprises a material prepared with the use of Zn doped sintering aid.

19. (Previously Presented) A method as claimed in claim 18, wherein steam electrolysis is carried out at a temperature of from 400 to 800°C.

20. (Currently Amended) A steam electrolyser apparatus for producing hydrogen, comprising: a dense proton-conducting membrane substantially non-porous to molecular gas, said membrane being supported on a gas permeable, chemically and mechanically stable, electronically conducting substrate, said membrane being coupled: at the substrate – supported side to an anode for connection to a positive voltage, and to a steam inlet and oxygen outlet for feeding a steam feed stream into said substrate and exhausting oxygen gas released therefrom; and at its other side to a cathode for connection to a negative voltage and a hydrogen gas outlet for exhaustion of hydrogen gas released at said cathode, wherein the membrane comprises a material prepared with the use of a Zn doped oxide sintering aid.

21. (Previously Presented) An apparatus as claimed in claim 20, wherein the substrate material is electrochemically active and the anode constitutes part of the substrate adjoining the membrane.

22. (Previously Presented) An apparatus as claimed in claim 20, wherein the anode comprises a thin layer of a different material interposed between the membrane and the substrate support.

23. (Currently Amended) Apparatus as claimed in claim 20, wherein the proton conducting membrane is often comprises oxygen deficient perovskite of formula $ABO_{3-\delta}$ wherein A and B represent metallic elements occupying the A and B sites of the perovskite lattice structure and δ represents the degree of oxygen deficiency.

24. (Currently Amended) Apparatus as claimed in claim 23, wherein said membrane material is selected from $\text{BaCe}_{0.9}\text{Y}_{0.1}\text{O}_{2.95}$ (BCY10), $\text{BaZr}_{0.9}\text{Y}_{0.1}\text{O}_{2.95}$ (BZY) and members of the solid solution, $\text{BaCe}_{0.9-x}\text{Zr}_x\text{Y}_{0.1}\text{O}_{2.95}$ (BCZY), or the analogues of the previously mentioned phases materials with lanthanides such as Gd, Nd or Yb instead of Y and such phases with analogues of the materials having higher degrees of substitution such as $\text{BaCe}_{0.8}\text{Y}_{0.2}\text{O}_{2.95}$ (BCY20), $\text{Sr}_3\text{CaZr}_{0.5}\text{Ta}_{1.5}\text{O}_{8.75}$ (SCZTO) and $\text{Ba}_3\text{Ca}_{1.18}\text{Nb}_{1.82}\text{O}_{8.73}$ (BCN18) composites of such materials.

25. (Previously Presented) Apparatus as claimed in claim 20, wherein the membrane is provided with an outer protective layer.

26. (Previously Presented) Apparatus as claimed in claim 20, wherein the membrane thickness is not more than $25\mu\text{m}$.

27. (Previously Presented) Apparatus as claimed in claim 26, wherein the membrane thickness is from 3 to $15\mu\text{m}$.

28. (Currently Amended) Apparatus as claimed in claim 20, wherein the membrane comprises a BaZrO_3 or BaCeO_3 -based material.

29. (Canceled)

30. (Currently Amended) A steam electrolyser apparatus for producing hydrogen, comprising: a dense proton-conducting membrane substantially non-porous to molecular gas, said membrane being supported on a gas permeable, chemically and mechanically stable, electronically conducting substrate, said membrane being coupled: at the substrate – supported side to an anode for connection to a positive voltage, and to a steam inlet and oxygen outlet for feeding a steam feed stream into said substrate and exhausting oxygen gas released therefrom; and at its other side to a cathode for connection to a negative voltage and a hydrogen gas outlet for exhaustion of hydrogen gas released at said cathode. Apparatus as claimed in claim 29, wherein the membrane is of $BaZr_{1-x}Ln_xO_{3-x/2}$ wherein X has a value in the range from (0.02) to (0.25) and Ln is a lanthanide ion or La, Y, Sc, and wherein said membrane is produced with the use of approximately 1% no more than 5% w/w of ZnO sintering aid.

31. (Currently Amended) A steam electrolyser apparatus for producing hydrogen, comprising: a dense proton-conducting membrane substantially non-porous to molecular gas, said membrane being supported on a gas permeable, chemically and mechanically stable, electronically conducting substrate, said membrane being coupled: at the substrate – supported side to an anode for connection to a positive voltage, and to a steam inlet and oxygen outlet for feeding a steam feed stream into said substrate and exhausting oxygen gas released therefrom; and at its other side to a cathode for connection to a negative voltage and a hydrogen gas outlet

for exhaustion of hydrogen gas released at said cathode, Apparatus as claimed in claim 29,

wherein the membrane is of $\text{BaCe}_{0.5}\text{Zr}_{0.3}\text{Y}_{0.16}\text{Zn}_{0.04}\text{O}_{2.88}$.

32. (Previously Presented) Apparatus as claimed in claim 20, wherein the substrate support is of a material which comprises a metallised ceramic or a mixed conductive oxide, having an electrical conductivity of not less than 10Scm^{-1} at the operating temperature of the steam electrolysis.

33. (Previously Presented) Apparatus as claimed in claim 32, wherein said substrate material is selected from $\text{Cu:Al}_2\text{O}_3$, $\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_3$ (LSM), chromium-doped LSM (i.e. $\text{La}_{0.75}\text{Sr}_{0.25}\text{Cr}_{0.5}\text{Mn}_{0.5}\text{O}_3$) and $\text{La}_{0.6}\text{Sr}_{0.4}\text{Co}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$ (LSCF).

34. (Previously Presented) Apparatus as claimed in claim 20, wherein the substrate support pore size is not less than $0.5\text{ }\mu\text{m}$.

35. (Previously Presented) Apparatus as claimed in claim 20, wherein the substrate porosity is from 30 to 60%.

36. (New) A method as claimed in claim 18, wherein the membrane material has been prepared using not more than 5%w/w of ZnO sintering aid.

37. (New) The method claimed in claim 36, wherein the membrane is of $\text{BaZr}_{1-X}\text{Ln}_X\text{O}_{3-X/2}$ wherein X has a value in the range from (0.02) to (0.25) and Ln is a lanthanide ion or La, Y, Sc.

38. (New) The method claimed in claim 37, wherein the membrane material is produced with the use of approximately 1%w/w of ZnO sintering aid.

39. (New) The method claimed in claim 18, wherein the membrane is of $\text{BaCe}_{0.5}\text{Zr}_{0.3}\text{Y}_{0.16}\text{Zn}_{0.04}\text{O}_{2.88}$.

40. (New) The method claimed in claim 18, wherein the membrane material comprises a Barium Yttrium Cerate based material.

41. (New) The method claimed in claim 40, wherein the membrane material comprises a Barium Yttrium Cerate Zirconate based material.

42. (New) The method claimed in claim 41, wherein the membrane comprises a material based on $\text{BaZr}_{1-x}\text{Y}_x\text{Zn}_z\text{O}_{3-z-x/2}$.

43. (New) The apparatus as claimed in claim 42, wherein the membrane material has been prepared using not more than 5%w/w of ZnO sintering aid.

44. (New) The apparatus as claimed in claim 43, wherein the membrane is of $\text{BaZr}_{1-x}\text{Ln}_x\text{O}_{3-x/2}$ wherein X has a value in the range from (0.02) to (0.25) and Ln is a lanthanide ion or La, Y, Sc.

45. (New) The apparatus as claimed in claim 44, wherein the membrane material is produced with the use of approximately 1%w/w of ZnO sintering aid.

46. (New) The apparatus as claimed in claim 18, wherein the membrane material comprises a Barium Yttrium Cerate based material.

47. (New) The apparatus as claimed in claim 46, wherein the membrane material comprises a Barium Yttrium Cerate Zirconate based material.

48. (New) The apparatus as claimed in claim 47, wherein the membrane comprises a material based on $\text{BaZr}_{1-x-z}\text{Y}_x\text{Zn}_z\text{O}_{3-z-x/2}$.

49. (New) The apparatus as claimed in claim 48, wherein the membrane is of $\text{BaCe}_{0.5}\text{Zr}_{0.3}\text{Y}_{0.16}\text{Zn}_{0.04}\text{O}_{2.88}$.

50. (New) An electrolyser system comprising a manifold interconnector adapted to mount a plurality of steam electrolyser apparatus as defined in claim 20.

51. (New) The apparatus as claimed in claim 23, wherein said membrane material comprises $\text{Ba}_3\text{Ca}_{1.18}\text{Ta}_{1.82}\text{O}_{8.73}$ (BCT18).